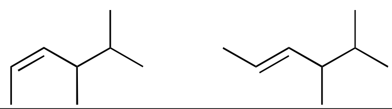
# CHIRALITY

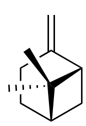
## Stereoisomers

- **Stereoisomers** = compounds having the same molecular formula and connectivity, but different 3D arrangements of atoms.
- A pair of stereoisomers are, by definition, non-superimposable on each other.
- A compound is said to be **chiral** (asymmetric) if its mirror image is not superimposable on the original image.
- Draw the mirror image of each compound. Are the pairs superimposable?

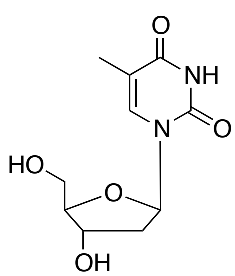


## Chiral Centers

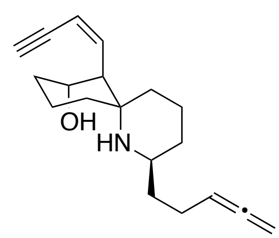
- **A carbon atom is *chiral* if it has four different groups/substituents.**
- How many chiral centers are in each biomolecule below?
    - o Indicate each chiral center with a star (*).



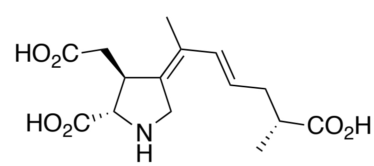
**β-Pinene**




**Deoxythymidine**



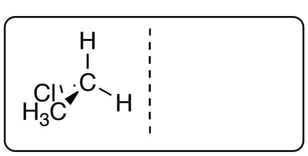

**Isodihydrohistrionicotoxin**

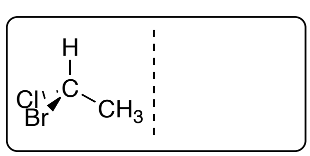


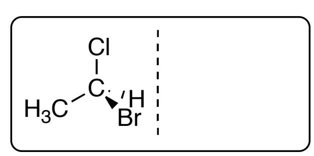

**Isodomoic acid H**

**A carbon atom is *chiral* if its mirror images are *non-superimposable*.**

IS IT CHIRAL? Draw mirror images of the following tetrahedral carbon atoms.



Is a <u>compound</u> chiral? This is a different question than "does the compound have chiral centers" or "is this carbon chiral?"

- Recall that a chiral compound is asymmetric, in other words, it does not contain a plane of symmetry. You can check this by drawing a mirror-image of the compound in question.
    - If the mirror-image is superimposable with the original compound, the compound is symmetric and is **achiral**.
        - It is possible for a compound with chiral centers to be achiral. These are called meso compounds. **<u>Meso compounds</u>** contain chiral centers but have a plane of symmetry and so they are *achiral*.
    - If the mirror-image is non-superimposable with the original compound, the compound is asymmetric and so is chiral.

EXAMPLES:

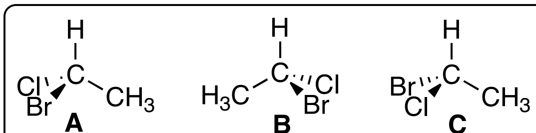
## THIS WILL BE THE MOST IMPORTANT PART OF THIS CHAPTER:

**<u>*R*/*S* Configuration</u> of a chiral center is how *absolute stereochemistry* is defined.**

1. The four different substituents are prioritized (just like E/Z prioritization).
2. Orient the carbon atom so that two bonds are in the plane, one is above the plane (bold wedge), and the *fourth priority group* is behind the plane (dash).
3. Orient that carbon atom so that the substituent of fourth priority is behind the plane (dash).
4. The remaining three substituents are counted in a circle: 1 then 2 then 3.
    a. If the 1-2-3 circle goes clockwise, the chiral center is of (*R*) configuration.
    b. If the 1-2-3 circle goes counter-clockwise, it is of (*S*) configuration.
5. Assign R/S configuration to compounds **A**-**F** below.

<u>Enantiomers</u> are a pair of compounds that are non-superimposable mirror images of each other.

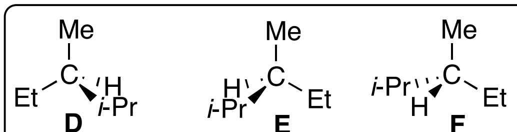
- For a given pair of enantiomers, any (*R*) stereocenters on one compound will be (*S*) stereocenters on the enantiomer, and *vice versa*.




A & B are enantiomers

B & C are the same compound

A & C are enantiomers




D & E are ________________

E & F are ________________

D & F are ________________

<u>Diastereomers</u> are a pair of compounds containing two or more chiral centers.

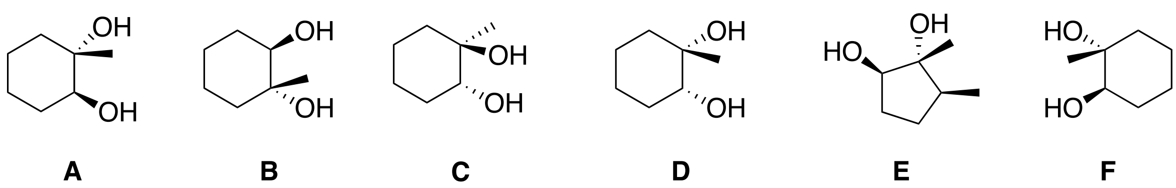
- For a pair of diastereomers, some of the chiral centers change in configuration, but at least one must be the same.
- Diastereomers are NOT mirror-images of each other (recall that non-superimposable mirror images are enantiomers

# CHIRALITY

Stereoisomers or not? If so, what kind?

**Assign R/S configurations for each stereocenter in the following compounds**

*Here's a trick: the normal way of assigning R/S requires the 4th priority to be behind the page. If the 4th priority is drawn in front of the page with a wedge, the configuration you assign is the opposite of how it looks. For example, if it looks like an R center with the 4th priority wedged, it is actually an S configuration.*




Indicate whether the following pairs are enantiomers, diastereomers, constitutional isomers, the same compound, or not isomers. You've already done the hard part by assigning R/S.

- For a given pair below, number the carbons, name the compounds, and write the formula.
  - **Constitutional isomers** – same molecular formula, and the name differs by more than the R/S designation.
  - **Not isomers** – different molecular formula.
  - **Enantiomers** – All of the R centers are S centers on the pair, and vice versa.
  - **Diastereomers** – At least one of the chiral centers has the same R/S designation, but the others are different.
  - **Same Compound** – Everything is the same!

A&B __________________ A&C___________________ A&D___________________

A&E __________________ A&F___________________ B&C___________________

B&D __________________ B&F___________________ C&D___________________

C&F __________________ D&F __________________ E&F____________________

A 50:50 mixture of A&F is called _______________________

The optical rotation value for this mixture is ______

What is the relationship between the optical rotations of A&F? ______________________

Which other pairs share this relationship? ________________________________________

What's the relationship between E and the rest of the compounds? ___________________